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Climate change and the carbon cycle of frozen floodplains.

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Permafrost-affected river plains are highly diverse in discharge regime, floodplain morphology, channel forms, channel mobility and ecosystems. Frozen floodplains range from almost barren systems with high channel mobility, to extensive wetland areas with low channel mobility, abundant abandoned channels, back-swamps and shallow floodplain lakes. Floodplain processes are increasingly affected by climate-induced changes in river discharge and temperature regime: changes in the dates of freeze-up, break-up and spring floods, and changes in the discharge distribution throughout the year.

In permafrost floodplains, changes in flooding frequency, flood height and water temperature affect active layer thickness, subsidence and erosion processes. Data from the Northeast Siberian Berelegh river floodplain (a tributary to the Indigirka river) demonstrate that increasing spring flood height potentially causes permafrost thaw, soil subsidence and increase of the floodplain area. INSAR (interferometric synthetic aperture radar) data indicate that poorly drained areas in this region are affected by soil subsidence. Morphological evidence for subsidence of the river floodplain is abundant, and river-connected lakes show expansion features also seen in thaw lakes.

These floodplain wetland ecosystems are also affected by changes in the discharge regime and permafrost. On the one hand, floodplains are sites of active sedimentation of organic matter-rich sediments and sequestration of carbon. This carbon is derived from upstream erosion of permafrost and vegetation, and from autochthonous primary production. Nutrient supply by flood waters supports highly productive ecosystems with a comparatively large biomass.

On the other hand, these ecosystems also emit high amounts of CH_4, which may be affected by flooding regime. In the example presented here, the CH_4 emission from floodplain wetlands is about seven times higher that the emission from similar tundra wetlands outside the floodplain.

The dynamic nature of floodplains hinders carbon and greenhouse gas flux measurements. Better quantification of greenhouse gas fluxes from these floodplains, and their relation with river regime changes, is highly important to understand future emissions from thawing permafrost. Given the difficulties of surface greenhouse gas flux measurements, recent remote sensing material could play an important role here.